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WATER SUPPLY AND WATER QUALITY CONTROL
STUDY, PEQUONNOCK RIVER BASIN,
CONNECTICUT

Public Health Service
Boston, Massachusetts

January 1965

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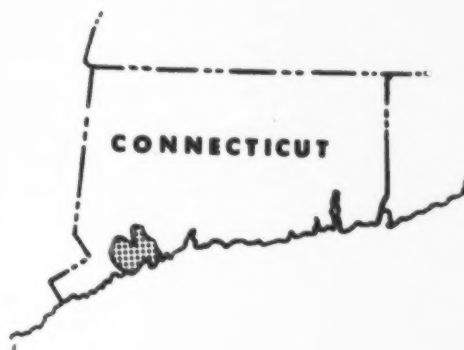
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**WATER SUPPLY
AND
WATER QUALITY CONTROL STUDY**

**PEQUONNOCK RIVER BASIN
CONNECTICUT**



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WATER SUPPLY
AND
WATER QUALITY CONTROL STUDY
PEQUONNOCK RIVER BASIN
CONNECTICUT

The study reported on herein has disclosed a future need in the Bridgeport, Connecticut area for additional municipal and industrial water supplies of drinking quality. There is a potential need for water storage for water quality maintenance of the Pequonnock River which is not related to the discharge of treated municipal and industrial wastes. These conclusions are based on an analysis of available data and projections of population and industrial growth based on economic and demographic studies.

Prepared for
DEPARTMENT OF THE ARMY
U. S. Army Engineer Division, New England
Waltham, Massachusetts

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region I
Division of Water Supply and Pollution Control
Boston, Massachusetts

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TABLE OF CONTENTS

	Page
LIST OF TABLES	1
LIST OF FIGURES	1
I INTRODUCTION	1
Authority	1
Purpose and Scope	1
Acknowledgments	2
II SUMMARY	3
III CONCLUSIONS	4
IV LOCATION AND DESCRIPTION OF PROJECT	6
V STUDY AREA	8
Economics	8
Population	9
VI DEMAND FOR WATER	11
VII WATER RESOURCES	13
Future Ground Water	13
Future Surface Water	14
Recreation and Water Supply	16
VIII STREAMFLOW REGULATION FOR WATER QUALITY CONTROL	18
Future Waste Control	18
Potential Water Quality Damages	20
Water Quality Control	21
IX VALUE OF WATER STORAGE	23
Water Supply Benefits	25
Water Quality Control Benefits	27
X BIBLIOGRAPHY	30
APPENDIX	32

LIST OF TABLES

Table

	Page
1 Study Area Projections	12
2 Water Quality Data	15
3 Pequonnock River-Water Quality Data	22
4 Cost Comparison for Water Supply Alternatives	26

LIST OF FIGURES

Figure

	Page
1 Population Projections	10
2 Location Map	29

APPENDIX

Computing Municipal and Industrial Water Supply Benefits	32
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I INTRODUCTION

In a letter dated August 26, 1963, the U. S. Army Engineer Division, New England, requested the Department of Health, Education, and Welfare's advice "...as to any interest the Department of HEW might have and whether purposes other than flood control and recreation, including fish and wildlife, should be considered," in a potential multipurpose dam and reservoir on the Pequonnock River in Trumbull, Connecticut.

Authority

This study of the water resources of the Pequonnock River Basin has been made in accordance with (1) the Memorandum of Agreement dated November 4, 1958, between the Department of the Army and the Department of Health, Education, and Welfare, relative to Title III of the Federal Water Supply Act of 1958, as amended (42 U. S. C. 390b) and (2) the Federal Water Pollution Control Act, as amended (33 U. S. C. 466a (b)).

Purpose and Scope

A study of the water resources of the Pequonnock River Basin has been made to determine the need for and value of present and future municipal and industrial water supply and the need for and value of water storage for streamflow regulation for water quality control which could be wholly or partially satisfied by the proposed project. This study estimates water storage needs and values for a 100-year period from 1970 to 2070 in ten communities in southeast Fairfield County, Connecticut.

Acknowledgments

The assistance and cooperation of agencies and individuals who helped in the preparation of this report are gratefully acknowledged. Special thanks are extended to the State of Connecticut Water Resources Commission and Department of Health; Metcalf & Eddy, Consulting Engineers; Corps of Engineers, New England Division; U. S. Fish and Wildlife Service; and the management and staff of the Bridgeport Hydraulic Company.

II SUMMARY

1. This report describes the need for and value of water to the year 2070 for municipal and industrial water supply and for water quality control purposes which could be partially satisfied by water storage in the multipurpose Trumbull reservoir on the Pequonnock River in Trumbull, Connecticut being studied by the Corps of Engineers. The Pequonnock River Basin has a drainage area of 29 square miles of which 13.8 square miles will be controlled by the proposed project.
2. The study area consists of the Pequonnock River Basin and the surrounding area that is served municipal and industrial water by the Bridgeport Hydraulic Company. This area is in the southwest corner of Connecticut and includes the towns of Trumbull, Easton, Fairfield, Monroe, Redding, Shelton, Stratford, Weston, and Westport, and the city of Bridgeport.
3. The population of the study area in 1960 was 321,000 of which about 292,000 persons were supplied municipal water by the Bridgeport Hydraulic Company.
4. The per capita water use in the study area for a population of 314,000 in 1963 was about 175 gal/cap/day which resulted in an average daily demand of 55 MGD with industrial users accounting for about 40 per cent of this demand.
5. The Bridgeport Hydraulic Company water supply system has a present safe yield of 72.5 MGD of which 57.5 MGD is from various surface sources and the rest from presently developed ground water sources.

6. There are no significant waste discharges to the Pequonnock River at the present time. Minor amounts of septic tank drainage, drain field drainage to storm sewers, and land runoff are however received in the stream as evidenced by limited stream sampling data.

7. The Connecticut State Health Department has encouraged local development of a plan for future disposal of the areas treated sewage to Long Island Sound.

III CONCLUSIONS

1. Based on demographic and economic studies, it is expected that the total municipal and industrial water demand in the study area will be 150 MGD in the year 2020 and 212 MGD in 2070 to serve a population of 719,000 in 2020 and 940,000 in 2070. It is anticipated that 40 per cent of this demand will be for industrial use.
2. The proposed Trumbull Dam and reservoir can supply only 9.0 MGD of the 77.5 MGD additional water supply required by the year 2020. The minimum net value of water supply storage in the Trumbull Project to supply 9.0 MGD will be \$121,500 annually starting in 1970. This value would apply if releases of 290 acre-feet annually, with an annual value of \$4,600 are made to maintain minimum natural flows in the stream in order to protect present water uses.
3. The Water Supply benefits have been estimated using the cost of the most likely alternate that would be used in the absence of the multipurpose project. The annual cost of the alternate includes annual taxes and operation and maintenance cost computed for the year 1975, the first year of water supply storage need, and discounted to 1970, the anticipated year of project completion.
4. Additional streamflow will be needed to control the effects of land drainage and urban runoff as the area becomes increasingly urbanized. Storage requirements for the project, however, cannot be ascertained until data are available from comprehensive water pollution control studies presently under way in the region.
5. Water Quality control benefits would be widespread both in area and purposes served. Recreational opportunities would be preserved and aesthetic values of an attractive stream would be maintained.

6. The value of benefits to be derived from streamflow regulation for water quality control as well as needed releases should be more fully evaluated at the design stage of the project.

IV LOCATION AND DESCRIPTION OF PROJECT

The proposed dam on the Pequonnock River is in Trumbull, Connecticut, approximately six and three-quarter miles above the river's mouth in Bridgeport Harbor. The project will have a permanent pool containing 7,800 acre-feet with a surface area of 200 acres at an elevation of 244 feet above mean sea level. In addition, 5,980 acre-feet of flood control storage is planned at a spillway crest elevation of 270 feet thereby forming a pool with a surface area of 268 acres. The flood-control storage provides for eight inches of runoff from a contributing drainage area of 13.8 square miles.

The drainage area has an average annual runoff of 24 inches as a result of an average annual precipitation of 46 inches. There are no gaging stations in the Pequonnock River Basin for determining the river's discharge and the terrain makes correlation of adjacent drainage areas very difficult. This lack of basic data hampered the quantitative results of the study with qualitative conclusions being made through discriminate use and analysis of the available data.

The Pequonnock River rises in the north central part of Monroe, Connecticut, and follows a meandering course in a general southerly direction for about 16 miles to Bridgeport Harbor, during which it falls nearly 440 feet while receiving the drainage from 29 square miles. In the town of Trumbull, the Pequonnock River flows through a section of steep hills and deep ravines before

reaching the city of Bridgeport where the river empties into
Bridgeport Harbor. See Figure 2, following page 28.

V STUDY AREA

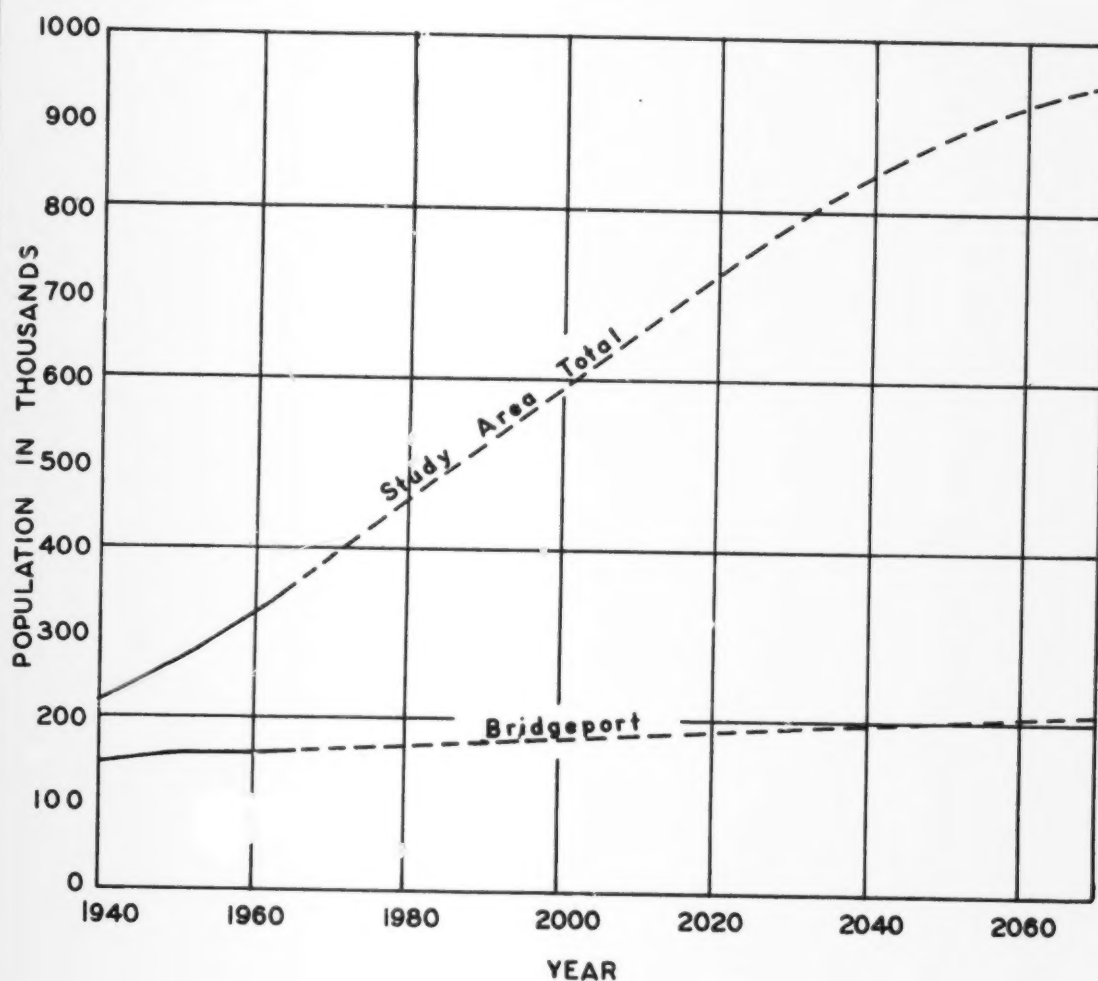
The area considered in the evaluation of the proposed multipurpose Trumbull Dam and Reservoir is the service area of the Bridgeport Hydraulic Company. This company supplies water of drinking quality to domestic and industrial users in the towns of Trumbull, Easton, Fairfield, ~~Monroe~~, Shelton, Stratford, Weston, and Westport, and the City of Bridgeport. The town of Redding has also been included in the study area since by 1980 it will need a municipal water supply which would most logically be furnished by the Bridgeport Hydraulic Company. The drainage area of the Pequonnock River lies wholly within this service area. The service area of the Bridgeport Hydraulic Company was selected for study because any water supply storage provided in the Trumbull project would be utilized to meet the needs of the entire built-up area.

Economics

The city of Bridgeport is an industrial center for the manufacture of brass goods, machine tools, hardware, and firearms. 2/ It is the central city of a large population complex with the suburban communities surrounding Bridgeport being mainly residential in character. Bridgeport lies within commuting distance of New York City, and consequently, is strongly influenced by the same factors which affect New York City. The economy of Bridgeport is strong and is making significant gains through modernization and diversification.

Population

The population of the service area was 321,000 in 1960, with 156,748 and 20,379 being located in Bridgeport and Trumbull, respectively. The City of Bridgeport showed a decrease in population of 1.2% between 1950 and 1960, which was due primarily to large numbers of people moving to the suburbs. For instance, Trumbull had a 135.8% gain in population between 1950 and 1960, and the service area as a whole had a 22% gain. ^{3/} Due to continued industrial development and economic growth in the New York City and Bridgeport areas, the population of the Bridgeport Hydraulic Company's service area is expected to continue increasing to 726,000 in 2020, and 950,000 in 2070. The population projection for the study area as developed from the economic and demographic studies is shown in Figure I.



WATER SUPPLY AND WATER QUALITY CONTROL STUDY
PEQUONNOCK RIVER BASIN
CONNECTICUT
POPULATION PROJECTION
DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
Region I Boston, Mass.

FIGURE 1.

VI DEMAND FOR WATER

The demand for municipal and industrial water of drinking quality supplied by the Bridgeport Hydraulic Company in its service area has increased from 34.7 MGD in 1950 to 54.7 MGD in 1963, which is an increase of about 1.5 MGD per year. The increasing demand for water is a result both of the larger population being served each year and the growth in per capita consumption of water.

The per capita water use is expected to increase to about 210 gal/cap/day in 2020 and 225 gal/cap/day in 2070 from the current rate of 175 gal/cap/day. The increase in per capita consumption is based on the assumptions that high-rise apartment will furnish much of the needed future living space and no heavy water-using industry will locate in the area. Forty per cent of the company's present demand is for industrial water supply, and this proportion is expected to remain about the same in the future.

Approximately 91% of the total population within the study area was being served domestic water by the Bridgeport Hydraulic Company in 1960. The proportion served is expected to increase to 99% by 2020 as a result of the rising population density and corresponding decrease in use of private water wells.

After a thorough consideration of the factors affecting the demand for water in the Bridgeport area, it appears that a reasonable estimate of the demand for municipal and industrial water of drinking quality to be supplied by the Bridgeport Hydraulic Company would be as follows:

TABLE I
STUDY AREA PROJECTIONS

<u>Year</u>	<u>Area Population</u>	<u>Per cent Served</u>	<u>Per Capita Consumption gal./cap./day</u>	<u>Water Demand MGD</u>
1960	321,000	91	167	49
1980	456,000	94	186	80
2000	591,000	98	197	114
2020	726,000	99	210	150
2040	840,000	99	218	182
2070	950,000	99	225	212

These water requirements do not reflect a demand for water exercised by an industry which might desire to provide its own water supply. A large demand for such water is not anticipated because of the high development cost of an independent water supply. Small industrial water supplies may be developed through the use of ground water, but these would be strictly limited in quantity, and are therefore not included. It is expected, therefore, that all significant water users within the study area will be supplied by the Bridgeport Hydraulic Company.

VII WATER RESOURCES

The Bridgeport Hydraulic Company presently has a safe yield of 72.5 MGD, with 57.5 MGD being supplied from various surface sources and 15 MGD from wells. The system's major source of ground water is from the Housatonic well field which presently has a safe draft of 12 MGD. The company has many surface sources of supply throughout the service area, of which Saugatuck, Hemlocks, Easton, and Trap Falls reservoirs are the most significant.^{13/}

The proposed Trumbull project is being planned for the development of 9.0 MGD for municipal water supply from a drainage area of 13.8 square miles. Presently the drainage from 3.8 square miles of the Pequonnock's watershed above the proposed Trumbull Dam site may be diverted to the Easton Reservoir in the adjoining watershed. Such an arrangement could reduce the yield from the Trumbull project but the yield from the combination of both reservoirs could result in increased yields. The Hydraulic Company plans on maintaining the diversion after the Trumbull Reservoir is completed in order to have operational flexibility so that either reservoir may be benefited by runoff from the upper watershed.

Future Ground Water

The Bridgeport Hydraulic Company has conducted an extensive search for additional ground water supplies, but this search has been unsuccessful in locating any sizeable quantities of new ground water sources. The Housatonic well field has an estimated ultimate development of 40 MGD, which constitutes an additional

development of 28 MGD. This is being carried out by the company on a step-by-step basis. The high cost of pumping indicates that it is more economical to provide surface sources of water supply within the service area rather than pump water from the Housatonic well field. Due to these economic factors, it is anticipated that all surface sources of water supply will be developed before the Housatonic well field is fully developed and the Trumbull project will be utilized by 1975.

Future Surface Water

The Trumbull Dam site is the last feasible location for the development of a surface water supply within the Bridgeport Hydraulic Company's service area around Bridgeport. The company owns most of the land to be inundated by the Trumbull Reservoir, and the company also owns diversion rights to the total flow of the Pequonnock River.

The Pequonnock River water is of relatively good quality except for bacteria, turbidity, and color contributed by surface runoff which would have to be removed to make the water suitable for drinking. Present plans indicate these undersirable qualities will be removed from the project water by sedimentation, filtration, and chlorination prior to pumping into the distribution system. Table 2 shows average values for several water quality parameters for the Pequonnock and Housatonic Rivers.

Including the addition of 9.0 MGD from the Trumbull Reservoir and 28 MGD from the Housatonic well field, the Bridgeport Hydraulic Company will have a safe yield of 109.5 MGD. This amount of water

will be needed before the year 2000. The only remaining major source of water supply is the Housatonic River which should be capable of furnishing ample water to meet additional future water demands. The water quality of the Housatonic River is relatively good at the site of the present well field where a future river intake would be constructed. Sedimentation, filtration, and chlorination or other suitable treatment would need to be provided for the river water obtained at this site to remove bacteria and turbidity. Downstream from this site is a major source of pollution from the Naugatuck River and the Towns of Shelton, Derby, and Ansonia. The water quality of the Housatonic River below its confluence with the Naugatuck River is degraded to the point that present water uses are restricted to certain industrial uses and transportation of wastes.

TABLE 2

WATER QUALITY DATA 13/
AVERAGE VALUES - 1964

	Pequonnock River		Housatonic River
	<u>Above Proj.</u>	<u>Below Proj.</u>	<u>Near Well Field</u>
Color (units)	26	23	21
Turbidity (units)	3	3	4
pH	7.1	7.1	7.5
Chloride (mg/l)	21	19.3	8.0
Iron (mg/l)	0.24	0.21	0.24
Total Hardness (mg/l)	57	47	88
Alkalinity (mg/l)	35	27	73
Nitrate as N (mg/l)	0.35	0.04	0.14
Total Solids (mg/l)	129	117	127
Coliform Bacteria (MPN per 100 ml)	5,000	14,800	1,300

Note: Averages represent the analysis by the Bridgeport Hydraulic Company of one grab sample for each location taken each month during 1964.

The Connecticut Light and Power Company at Stevenson, Connecticut, presently regulates the Housatonic River flows upstream of the area most likely to be developed by the Bridgeport Hydraulic Company for future water supply. 7/ 8/ It is expected, however, that when water is needed from the Housatonic River, satisfactory agreements on water releases will be made between the two utility companies.

It is concluded that the Bridgeport Hydraulic Company has adequate sources of supply to meet its present water demands, that in the future the company will need to develop additional sources of supply to meet the water demand generated by a growing population, and that there are adequate sources of water available for development. The proposed dam and reservoir on the Pequonnock River will provide an excellent opportunity for the Bridgeport Hydraulic Company to develop an additional source of water supply of 9 MGD.

Recreation and Water Supply

Recreational use of the proposed Trumbull Reservoir is being planned as a project purpose. Such use poses a potential hazard to the quality of the water stored in the reservoir for domestic use unless adequate measures are taken to prevent the pollution of the watershed and reservoir area. As recognition of the potential hazard, Connecticut law prohibits the use of domestic water supply reservoirs for water contact sports, 23/ and it has been the policy of the Connecticut State Department of Health to prohibit any recreational use of water supply reservoirs.

There is a current trend in the United States to use water reservoirs for more than one purpose including the combining of limited,

controlled recreation and water supply where the water from the reservoir receives suitable treatment before it is used for drinking. By legislation, recreation and water supply are both recognized and approved uses of Federally constructed reservoirs. Hence, the Public Health Service raises no objections to such uses provided necessary safeguards are applied to the watershed and reservoir areas when public water supplies are involved. Such safeguards require consideration of both the degree of treatment provided to the water for the production of domestic water, together with the establishment of pollution control measures to be applied to both the watershed and upstream reservoir areas.

In the Trumbull Project, only limited, well-controlled recreational activities such as boating, fishing, and picnicking are being considered for development. The Bridgeport Hydraulic Company has informed the Corps of Engineers that these activities "could be allowed without violating good water supply practice." The Hydraulic Company has also stated that the Corps of Engineers would have to be responsible for the construction, maintenance, and supervision of the recreational facilities.

The water stored in the Trumbull Reservoir is to be treated by sedimentation, filtration, and chlorination, thus preventing any pollution resulting from recreational use from reaching the water consumers. Based on information available at the present time, there does not seem to be any compelling reason why well-controlled, limited recreational use of the proposed water supply reservoir at Trumbull should not be permitted.

STREAMFLOW REGULATION FOR WATER QUALITY CONTROL

At the present time there are no important domestic or industrial waste discharges to the Pequonnock River.^{15/} The only major concentration of population along the upper Pequonnock River is located in Trumbull; but at this time, Trumbull does not have a sewerage system. The only domestic waste discharges to the river result from the leaching of septic tanks and drain fields into storm sewers discharging to the Pequonnock River. There are no known domestic or industrial wastes being discharged directly to these storm sewers; however, bacteriological samples collected from the Pequonnock River by the City of Bridgeport Health Department indicate that surface runoff through these storm sewers apparently creates a bacterial pollution problem.^{14/}

Future Waste Control

The Town of Trumbull has initiated preliminary planning for a separate domestic sewage collection system and treatment plant which would alleviate many of the above problems; but because of the many difficulties involved, no definite action has been taken. A possible site for a sewage treatment plant to serve Trumbull would be on the Pequonnock River near the boundary between Trumbull and Bridgeport, which would be downstream from the Trumbull Dam site. Such a sewage treatment plant would provide secondary treatment, and flow regulation would be needed to maintain stream quality, especially during periods of low flow. However, downstream of such a project, the Pequonnock River flows through the City of Bridgeport's Beardsley Park where

a small dam forms Bunnell's Pond. The pond is used for swimming, and the adjacent park land for picnicking, sunbathing, and other recreational purposes. Because of this recreational development, any plan to discharge sewage above Bunnell's Pond has been opposed by the city of Bridgeport and the Connecticut State Department of Health. Due to these objections, Trumbull's Consulting Engineer has recommended that an outfall sewer be built to carry the treatment plant's effluent downstream of Bunnell's Pond.^{18/} Such a line would be about $2\frac{1}{4}$ miles long and would discharge $2\frac{1}{4}$ miles above the mouth of the Pequonnock River in Bridgeport Harbor. If the outfall is proposed for construction, studies should be carried out to determine the effect of the treated sewage on the water quality of the Pequonnock River estuary.

To provide the greatest degree of public health protection and the most efficient sewerage system, the Connecticut State Health Department has encouraged the development of a regional sewerage plan for the Bridgeport-Trumbull Area. The objective of such a plan would be ultimate disposal of the area's treated sewage to Long Island Sound with provision for the discharge of Trumbull's sewage to a regional sewerage system. This would be the most satisfactory solution to Trumbull and the adjacent area sewerage problem. But institutional arrangements, financial difficulties, and technical problems pose obstacles to such a solution.

Notwithstanding difficulties, no future waste discharges of any importance to the Pequonnock River are anticipated. The city of Bridgeport's sewage treatment plants discharge to Long Island Sound,

and no sewage discharges by Bridgeport to the Pequonnock River are foreseen. Since most of the drainage area of the Pequonnock River has been developed as residential areas, no industrial waste discharges to the Pequonnock River are to be expected.

It is concluded from information presently available that in the Pequonnock River Basin there is no current need, nor is any need anticipated in the future, to provide water storage for stream-flow regulation in order to reduce waste concentrations and thereby prevent water quality deterioration due to the discharge of treated municipal and industrial wastes.

However it is expected that surface runoff will become an increasingly significant factor affecting the water quality of the Pequonnock River as the area becomes urbanized. As additional data on the wastes from urban runoff becomes available, further studies will need to be carried out to determine the effects of these wastes on the Pequonnock River.

Potential Water Quality Damages

At the present time, the Connecticut Board of Fisheries and Game leases land along the Pequonnock River between Beardsley Park and the proposed dam site. This area provides a natural habitat for fish and wildlife indigenous to the region and is also used for "put and take" pheasant hunting and trout fishing. This is a delightful area aesthetically and the recreational features are outstanding.

The proposed Trumbull Dam will alter considerably the Pequonnock River flows and seriously affect both the recreational facilities

and the aesthetic value of the area in general. During periods of low flow, which most often occur in the summer months, the runoff from 13.8 square miles of drainage area would be cut off by the proposed project. This would result in deterioration of water quality as well as reduce streamflow below the level necessary to maintain a suitable fish and wildlife habitat. Damages to water quality would include, but not be limited to, reduced dissolved oxygen levels, higher water temperatures, and the build-up of algae and bacteria, all of which would diminish the aesthetic character and beneficial uses of the river.

In order to prevent the accrual of damages to present water uses due to the Trumbull project, it will be necessary to provide additional water storage to maintain the present minimum conditions of streamflow. An annual release of 290 acre-feet will be required from the water supply reservoir to maintain present conditions of streamflow and thereby prevent damages.

Water Quality Control

While it is not anticipated that there will be direct discharges of adequately treated wastes to the Pequonnock River, studies have shown that urban runoff carried into streams can be significantly polluted by accumulated deposits of oil, organic matter, and soil. It is only recently that thoughtful consideration has been given to the possible serious effects of these wastes on stream water quality. Due to the intermittent nature of the pollution, differences in precipitation patterns, character of the runoff area, and conditions in the receiving waters it is not possible to readily extend the

limited available information to the Pequonnock River. It is apparent, however, that there may be a need for flow regulation to assure water quality of a level necessary to maintain present and desired water uses. Any needed water releases for such quality control problems should be more fully evaluated at the design stage of the project.

The downstream resources of the Pequonnock River can be more fully developed by providing flow regulation for water quality control. Table 3 shows the limited available data on water temperature, dissolved oxygen and biochemical oxygen demand of the Pequonnock River.

TABLE 3
PEQUONNOCK RIVER - WATER QUALITY DATA 22/

	<u>Temperature</u> <u>oF</u>	<u>Dissolved</u> <u>Oxygen</u> <u>mg/l</u>	<u>Biochemical</u> <u>Oxygen</u> <u>Demand</u> <u>mg/l</u>
Above Project	68	7.8	3.3
Below Project	75	7.6	3.7
Bunnell's Pond			
Inlet	77	8.8	N. A.
Outlet	77	9.0	5.9

Note: Data shown is for one set of grab samples collected by the Connecticut State Department of Health on September 9, 1964.

The Connecticut Board of Fisheries and Game estimates that a 1.9 MGD release from the project site would be adequate to support a permanent trout stream habitat. A preliminary investigation by the U. S. Fish and Wildlife Service also indicates that additional

flow will increase the fisheries resources of the Pequonnock River. Additional fishing opportunities, especially trout fishing, would add considerably to the recreational values of the Pequonnock River.

A reduction in summer temperatures in the stream can be effected by releases of cold water from the project. It is anticipated that the stream reach from the project to Bunnell's Pond could be converted from a warm-water fishery to a cold-water fishery if such temperature control releases are properly managed.

A cold-water fish, such as trout, must have a minimum of 5 mg/l of dissolved oxygen with a maximum water temperature of 75 degrees Fahrenheit. Slight variations in either parameter for short periods of time should not have adverse effects on a cold-water fish, but it is extremely important to prevent the possibility of major variations in either parameter lest a fish kill result. Therefore, it is necessary that multiple level outlets be installed in the Trumbull dam so that water of the proper water quality may be selected from the reservoir.

Streamflow regulation for water quality control will provide a continuous flow of water in the river below the project site and will thereby tend to stabilize dissolved oxygen levels, and reduce algal growths and bacteria populations. Provision for water quality control will maintain a suitable environment for fish and wildlife promulgation and will insure the necessary quality needed to maintain recreation and natural beauty along the river.

Flow regulation will have direct benefits to local citizens and to interstate travelers. The local population will have increased to 726,000 by 2020 and 950,000 by 2070. The two major

highway routes between New York City and Boston cross the Pequonnock River at Bridgeport, Connecticut, and utilization of the available facilities by travelers can be expected. It is considered that the possible benefits for water quality control would be widespread in scope.

Due to the limited available data on the water quality of the Pequonnock River, it has not been possible up to the present time to determine the amount of water storage required to maintain and enhance the water quality of the Pequonnock River. At the time of design studies, information and data will be available from comprehensive water pollution control studies now under way which will make possible a determination of required water storage for water quality control purposes.

IX VALUE OF WATER STORAGE

The following quotation from Senate Document No. 97 (87th Congress, 2nd session)¹¹/ defines the generally accepted method for evaluating the benefits of water resource development projects.

"The amount water users should be willing to pay for such improvement in lieu of foregoing them affords an appropriate measure of this value. In practice, however, the measure of the benefit will be approximated by the cost of achieving the same results by the most likely alternative means that would be utilized in the absence of the project."

Water Supply Benefits

The alternative cost method has been used in this report to evaluate the minimum benefits to be derived from storage for municipal and industrial water supply.

Two alternatives are available to provide the same municipal and industrial water supply as the multipurpose Trumbull Dam and Reservoir. One alternative would be a single-purpose dam and reservoir of 6,450 acre-feet capacity at the proposed project site, and the other would be construction of pumping facilities and a pipeline to provide water from the Housatonic River. As previously noted, a water supply reservoir on the Pequonnock River without provision for maintaining present conditions of minimum flows would seriously damage downstream recreational uses, whereas pumping from the Housatonic River would not be detrimental to other water uses. The cost of preventing damages to these recreational uses has been used to determine the minimum cost of the potential damages that would be caused by the Trumbull project. In order to prevent

damages, a release of 290 acre-feet annually in addition to the 6,450 acre-feet of water supply storage, would have to be provided to maintain present minimum conditions of streamflow. A cost comparison of the alternatives is shown in the following table:

TABLE 4
COST COMPARISON FOR WATER SUPPLY ALTERNATIVES

	<u>Pumping Sta. & Pipe Line</u>	<u>Single-Purpose Res. 6,450 a.f.</u>	<u>Dual-Purpose Res. 6,740 a.f.</u>
Investment Cost	\$2,429,000	\$2,574,000	\$2,690,000
Annual Cost	87,500	92,700	96,900
Annual Oper. & Maintenance	144,000	21,500	21,500
Taxes	26,500	27,500	28,700
Total Annual Cost	258,000	141,700	147,100
Discount 5 yrs. (1975)	221,000	121,500	126,100

The above comparison readily shows that pumping would be cheaper if it were not for the high annual operation and maintenance charge; therefore, a single-purpose water supply reservoir is the least costly alternative. For the above analysis, it has been assumed that the project would be completed in 1970, and the year of first use would be 1975. An amortization period of 25 years at 4 per cent interest has been used to determine the annual payment stream required to develop the alternative water supply by private interest.

The annual value of the potential damages due to a single-purpose water supply reservoir would be \$4,600; i.e., \$126,100 minus \$121,500.

If damages are prevented by the inclusion of additional storage, the annual value of providing water supply storage in the Trumbull project would be $\$126,100 - \$4,600 = \$121,500$.

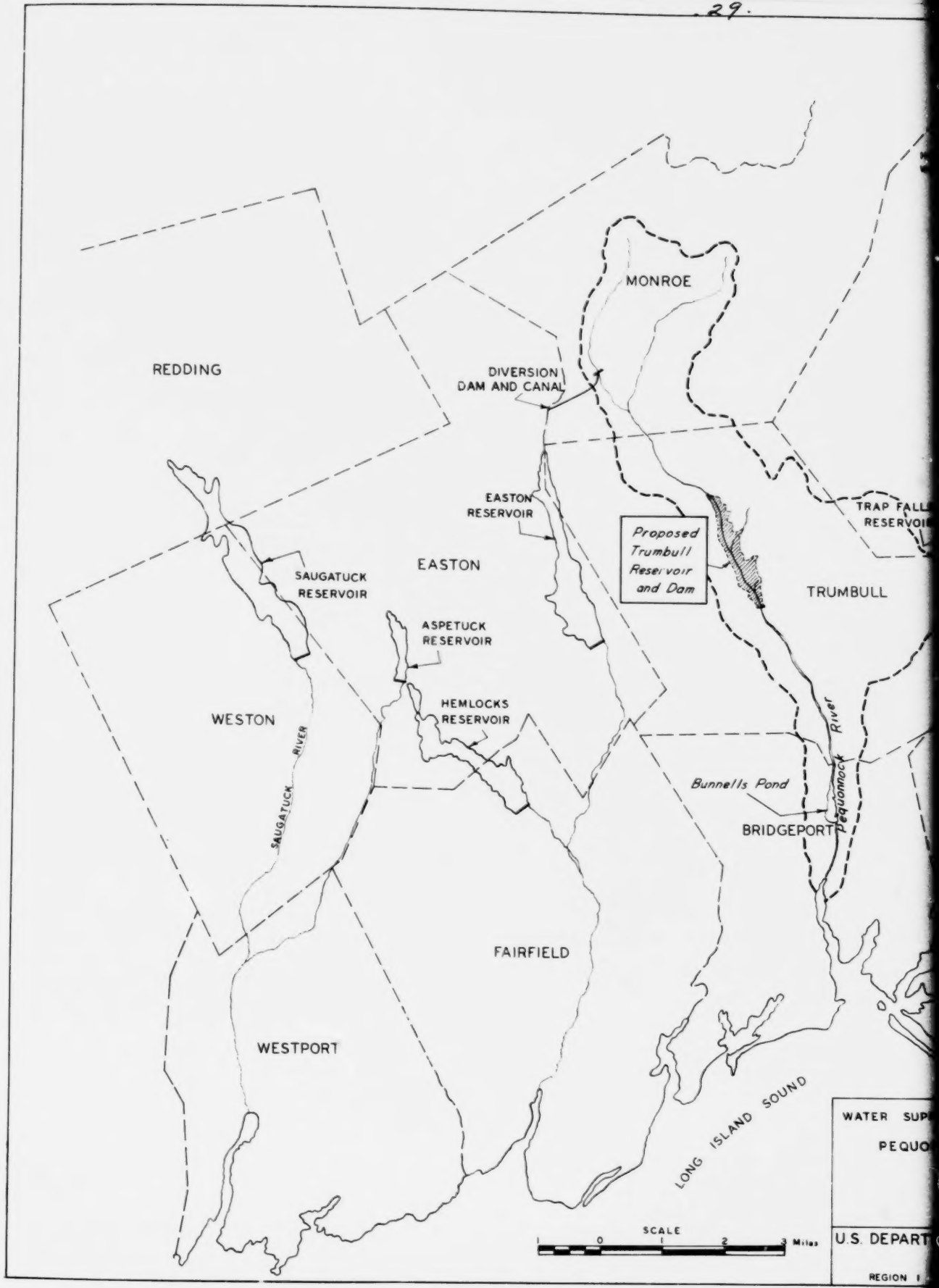
Water Quality Control Benefits

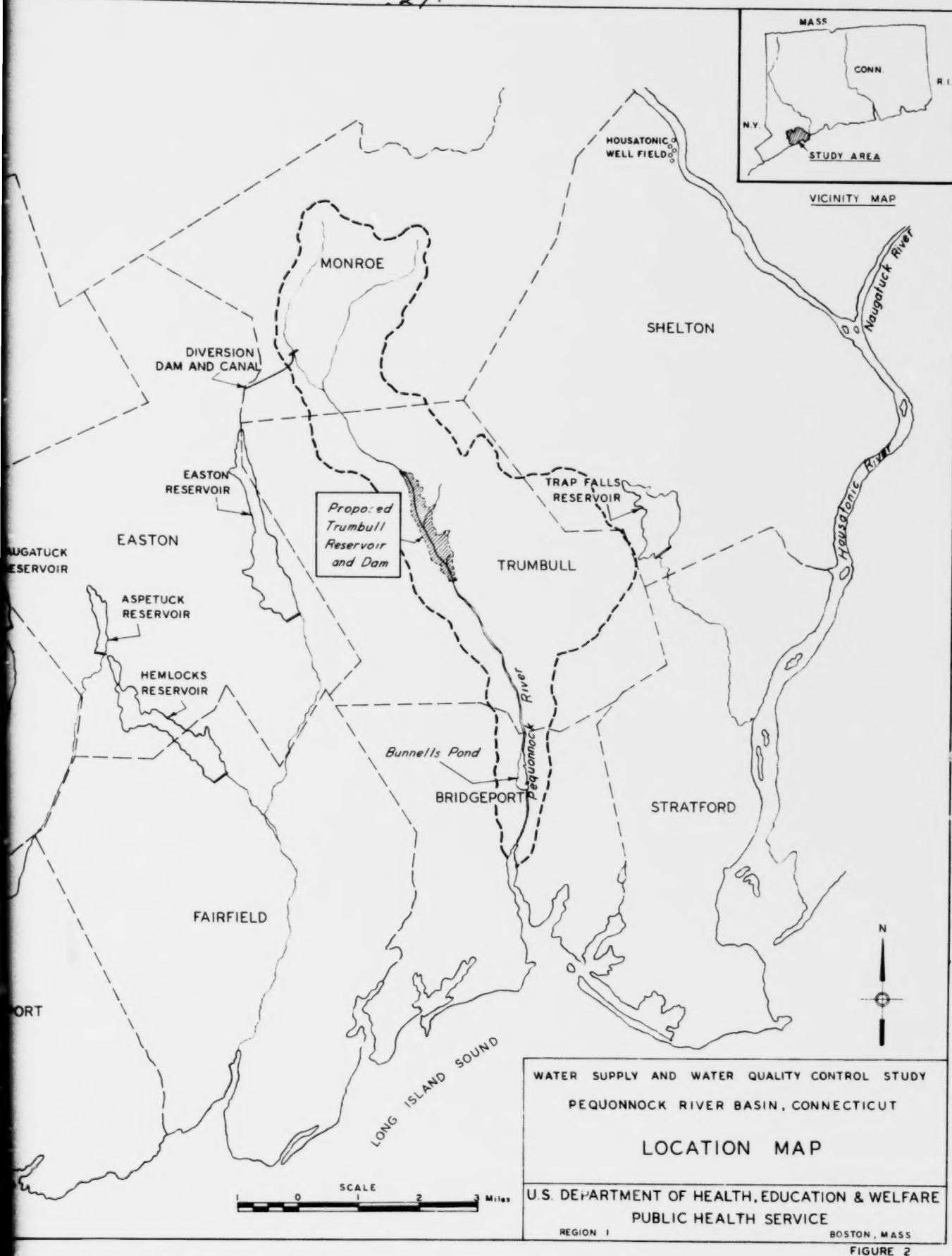
The possible benefits to be gained by maintenance of the water quality of the Pequonnock River through the use of water storage for streamflow regulation are considered to have real value in satisfying human desires; but such benefits generally are not fully measurable in monetary terms, and are often intangible. A portion of such benefits are measurable by the least costly, most likely alternative that would be utilized in the absence of the project. The cost of this alternative affords a measure of the minimum value of the benefits to be derived from water quality control.

The only feasible method of achieving water quality control in the Pequonnock River is to provide water storage for streamflow regulation. The most likely alternative to the multipurpose Trumbull Reservoir would be a single-purpose reservoir at the project site which would provide a continuous flow in the river at all times. The proposed project site is the most economical site available for water storage within the Pequonnock River drainage basin, and a single-purpose reservoir at the project is the only reasonable alternative to a multipurpose project.

Since the required storage for water quality control in the Trumbull Project cannot be determined at this time, no value can be placed on the benefits to be derived from water quality control. However, it is felt that water quality control should be included

as a project purpose to which benefits will be ascribed when quality needs are more adequately defined by comprehensive water pollution control studies now under way.





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APPENDIXCOMPUTING MUNICIPAL AND INDUSTRIAL WATER SUPPLY BENEFITS

Investment cost of single-purpose water supply reservoir with
6,450 acre-feet of water storage yielding 9.0 MGD is \$2,574,000.

25 yr. payment stream @ 4%: $0.06401 (\$2,574,000) = \$164,800$

Present worth, 25 yrs. @ $3 \frac{1}{8}\%$: $17.17308 (\$164,800) = \$2,829,500$

100 yr. payment stream @ $3 \frac{1}{8}\%$: $0.03276 (\$2,829,500) = \$92,700$

Annual Operation and Maintenance: 21,500

Annual Taxes: 27,500

Total Annual Cost: \$141,700

Construction completed 1970, year of first use 1975; therefore,
discount 5 years.

Annual benefit from 1970: $0.8574 (\$141,700) = \$121,500$